THE
VETERINARY JOURNAL

BOVINE DISEASES

It seems many a long year since a book on Bovine Diseases has been issued in the British Veterinary Press. This is not as it should be, especially considering the present-day importance of the ox to veterinary practice and work. It is true that this meat and milk producer has had considerable attention paid to its ailments in encyclopedias and systems of veterinary medicine, but no single authoritative work has been produced at all recently on the medicine and surgery of this valuable animal.

Cattle men like Martin, 1857, and veterinarians such as John Henry Steel, 1887, and George Armytage, 1893, were enthusiastic and prolific writers on the subjects of bovine management, diseases and therapeutics, and each of them produced an informative and educational book on the ox and its ailments as known up to their time. Since their day the veterinary medicine and surgery of the ox have made immense strides, and although the field of obstetrics has received modern attention no up-to-date book by a Britisher has appeared on Bovine Pathology and Diseases of the Ox.

An excellent book in the German language on the Diseases of the Ox by Dr. Weber, of the University of Leipzig, appeared in 1927 and was very helpful to those who could read German, but even since then improvements and advancements in the medicine and surgery of bovines have necessitated a more recent second edition.

In the French language quite a timely work, entitled "La Chirurgie du Bétail et des Animaux de Basse-Cour," by an experienced veterinarian, M. Berthelon, has been published, but it is limited to surgery.

Any informative and useful work on the ox ought to start with a good descriptive view of the animal in health and its physical and physiological activities. Experimental work in this direction has been conducted in America and data have been compiled on various bovine activities such as:

The percentage time standing and lying;
The daily water consumption;
Amount of urine and fæces voided daily;
Number of urinations and defæcations daily;
Time spent in eating and rumination.

Add to these a knowledge of dairy cow nutrition, vitamins, and form.

type and constitution of healthy stock and a foundation is established for a consideration of the many maladies and diseases that afflict the herds in our land.

It is too often assumed that a knowledge of the cow in health is possessed by all cow owners and dairymen.

NATIONAL VETERINARY MEDICAL ASSOCIATION—YARMOUTH CONGRESS

Among the many good things heard at the National Veterinary Medical Association's Congress at Yarmouth, few gave greater pleasure than the announcement that the Colonial Office had consented to reappoint an Adviser in Animal Health.

The post has been vacant since the death of Mr. R. E. Montgomery. The need of such an officer is apparent to us all, and though the finding of another Montgomery may not be an easy task, for men with knowledge of animal diseases combined with administrative ability and tact are rare, we hope that the Colonial Office may soon be successful in finding the right man.

Colonial veterinary officers are hard workers and get things done under conditions of which we have little conception.

We congratulate and thank the officials of the N.V.M.A. on their success in bringing about the decision. It has not been done without strenuous and persistent representations on their part.

General Articles

OBSERVATIONS AND EXPERIMENTS ON GIZZARD EROSION IN POULTRY

By W. P. BLOUNT, Ph.D., F.R.C.V.S.

THE problem of gizzard erosion appears to have received little attention in this country, for it is rare to find mention of it in veterinary literature, and as far as can be ascertained no records are available as to its incidence or economic importance in Great Britain.

In America the subject is well known, a number of papers have been published concerning its ætiology and it is recognised that the condition is common throughout the States. However, the causal nutritive factor has still to be identified although much of the experimental work suggests that it is a vitamin of fat-soluble origin; and contrary to the hæmorrhagic syndrome associated with vitamin K deficiency it is of widespread occurrence amongst chicks not fed synthetic or simplified diets.

Literature

One of the earliest references to gizzard erosion was that by McFarlane, Graham and Richardson (1931) who reported that the condition was noted in chicks fed on certain simplified diets. Later it was noted by Holst and Halbrook (1933), Dann and Schonheyder (1934) and Almquist and Stokstad (1935) in work concerned with the hæmorrhagic factor—vitamin K, but Jukes (1937) points out that a comparison of the diet used by all these workers showed that it was free of dried green foods which are now normally used in chick rations. However, experiments showed that supplies of the anti-hæmorrhagic factor sufficient to delay the blood clotting time did not influence gizzard erosion formation. Almquist and Stokstad have carried out important studies on the problem and concluded as a result of their researches that gizzard erosions are caused by a deficiency in the diet of a fat soluble factor, but one that was not identical at that time (1937) with any of the known vitamins. They describe the gizzard factor as comparatively unstable to heat and alcoholic potash, but indicated that it was readily adsorbed from solution in hexane by magnesium oxide. The factor appeared to be present in the *saponifiable* fraction of the oil and the best practical sources of the vitamin were fresh or dried greens and wheat bran. Their observations did not lead them to the conclusion that the gizzard factor was one associated with growth.

Shortly before the publication of this paper, Kline, Bird, Elvehjem and Hart (1936) reported that dried hog lung tissue was an effective supplement for the prevention of gizzard erosion, but Almquist and Stokstad were unable to confirm this statement. These latter workers employed " an arbitrary standard for scoring the severity of the gizzard lesion, a single plus sign representing a distinct erosion, two plus signs a severe erosion and three plus signs a very severe and widespread erosion. Doubtful cases were given a value of one half plus." The researches of the workers showed that whole alfalfa at a 10 per cent. level did not prevent distinct erosions, and even as high as 20 per cent. although the lesions were much less severe they were not completely prevented. However, practically complete prevention was obtained using 25 per cent. alfalfa hexane extract, but birds fed fresh kale *ad lib* were found to be entirely free of lesions.

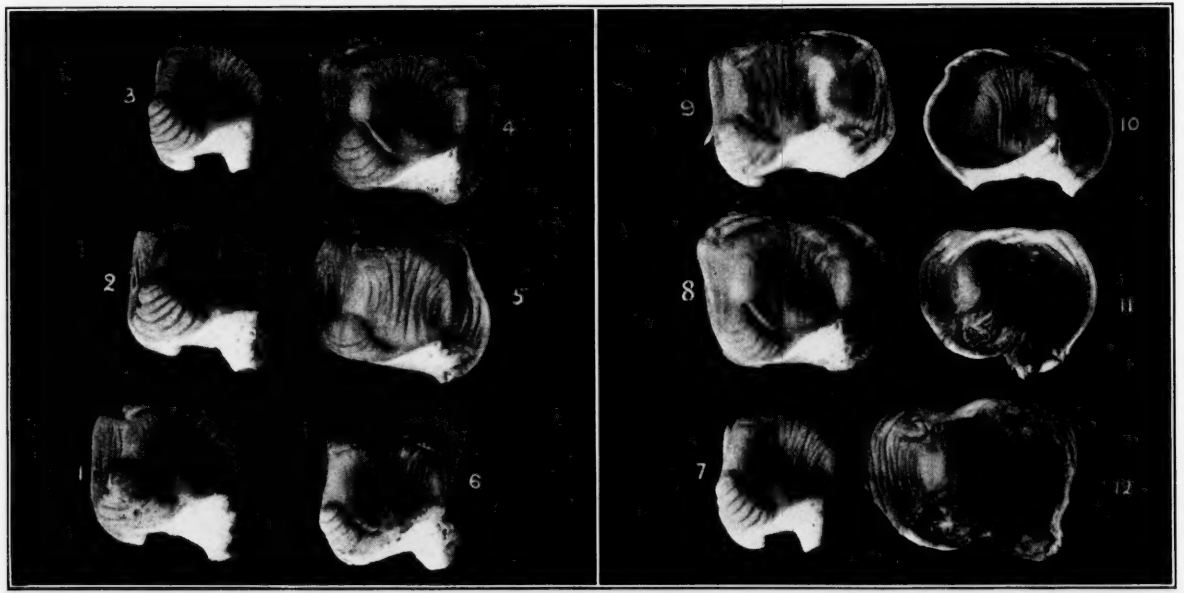
Almquist and Stokstad further stated that " experience with practical chick diets led to the observation that diets containing wheat bran in addition to the dried alfalfa were productive of very slight erosions, if any." However, their actual experiments showed that it required about 22 per cent. of hexane extract of wheat bran plus 1.5 parts alfalfa hexane extract, or 12 per cent. whole bran plus 18 per cent. of alfalfa hexane extract before the lesions were controlled.

In their valuable and interesting review of the problem entitled " The Gizzard Factor of the Chick " Almquist and Stokstad (1937) published some interesting photographs in the Journal of Nutrition, which showed quite clearly that the condition observed by them was probably identical with that which exists in this country. Their description of the malady is of interest—" This gizzard disorder of chicks is characterised by erosion or necrosis of the secreted gizzard lining, usually at the cardiac end of the gizzard but often in other portions. The erosions frequently are confined to the surface of the lining but may be severe enough to penetrate the epithelium and the muscular gizzard walls. The lining near the erosion is frayed and loosened in most cases and may be brown or black coloured. The unaffected lining is usually quite coarsely ridged."

This review also points out that although the hæmorrhagic syndrome had not been reported in chicks reared under normal conditions, not only had gizzard erosion been observed in chicks sent for routine pathological examinations, but it had also been observed in chicks in the late stages of incubation and in day-old chicks. (Holst and Halbrook, 1933).

Jungherr (1933a) observed a severe outbreak of mycosis in chicks characterised by whitish ulcers or pseudo-membranes in the crop, brownish or mucoid deposits in the proventriculus and ulcers in the gizzard. Yeast-like fungi were isolated from the chief lesions and experiments showed that the most pathogenic species was *Monilia albicans*. Jungherr's description of the gizzard lesions is important—he writes " the corneous lining of the gizzard frequently

PLATE I



Gizzards 1-6 all show hæmorrhages in that portion of the gizzard associated with the proventriculus. Numerous fine pin-point hæmorrhages will be seen, with actual ulceration in Nos. 5 and 6. The lining membrane generally of these gizzards shows roughening, with commencing ulceration in No. 6. Gizzards 7-12 show erosion lesions with increasing severity. No. 7, hæmorrhages at the gizzard-proventricular junction. These are more marked in No. 8. The roughening and corrugations of the gizzard lining membrane are accentuated in No. 9. Ulcers are appearing in gizzard No. 10, sloughing of the membrane is taking place in No. 11, and gizzard No. 12 shows advanced erosion.

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revealed ulcers, especially in the cardiac region, or old hæmorrhages which were visible by transmitted light. The true mucous membrane of the gizzard had usually lost its normal glossiness and appeared opaque and grayish white, or it showed whitish shallow ulcers." In a further communication, Jungherr (1933b) suggests the term *Moniliasis* for the disease in question, and wisely confirms later (1934) that "it should become an established practice to examine the mucous membrane of the crop, proventriculus and gizzard at *post-mortem* examination" since "the corneous lining of the gizzard may show superficial ulceration in mycosis of the fowl."

Bird and Oleson (1938) presented a preliminary report suggesting that chondroitin sulphuric acid (C.S.A.) was the gizzard erosion factor, but a comprehensive experiment by Crandall, Jr., and Chesley, and Gray and Robinson (1938-39) disproved this statement. Their work was undertaken on the assumption that C.S.A. exhibited similar properties to those described by Kline and his collaborators (1936) for the active portions of hog lung tissue. It was concluded that vitamin K might decrease the extent of the gizzard lesions merely by preventing hæmorrhage, but that chondroitin sulphuric acid was definitely not the gizzard erosion preventive factor, although in some instances it appeared to increase growth.

The Gizzard in Health

The general external appearance of the gizzard with its characteristic distribution of red muscle is well known, as is the inner chitinous lining membrane, but the histological appearance of the healthy gizzard is probably much less familiar to most pathologists. Bradley's (1915) original description of the organ has been amplified considerably by Calhoun (1933), who points out that there is no muscularis mucosæ, and that the submucous coat consists mainly of a dense layer of white fibrous tissue, although there is a lesser amount of yellow elastic connective tissue and, of course, the usual blood vessels, lymphatics and nerves. It is this layer which is found closely adherent to and inseparable from the main muscular layer, and which can be demonstrated so clearly once the inner horny layer has been removed by stripping. This horny layer is considered to be "an exudate from adjacent tubular glands situated in the tunica propria, arranged in groups and lined by low colloidal epithelium." The horny (keratohyalin) secretion is apparently formed by consecutive layers of the exudate uniting together with a certain amount of cellular debris. The epithelium of the mucous membrane itself is simple, columnar, and contains numerous crypts into which open the tubular glands. This undoubtedly accounts for the velvety (villous-like) appearance of the horny lining membrane (as seen during the stripping-off process), and explains how it is possible for the membrane to peel off much easier in some cases than others. Obviously much will depend upon the correct functioning of the

glands, although this in turn will be related directly to the state of their nutrition. Calhoun also reports the sharp line of demarcation observed histologically between the proventriculus (the deep glands of which end abruptly) and the succeeding portion of the digestive tract joining the proventriculus to the gizzard proper. Here there is an increase in the *length* of the tubular glands, but these soon assume the characteristic aspect of the gizzard glands, and a keratinised layer is observed above them.

During a naked eye examination of the gizzard, three or four features are noteworthy. The grooved appearance of the horny layer is due to furrows which often run parallel to its long axis. Calhoun considers that the ridges on either side of these furrows (and which are therefore perpendicular to the surface) are formed "by secretion being poured out at the same point," whereas certain microscopic wavy lines she believes are due "to the formation of consecutive layers of the exudate."

Observations

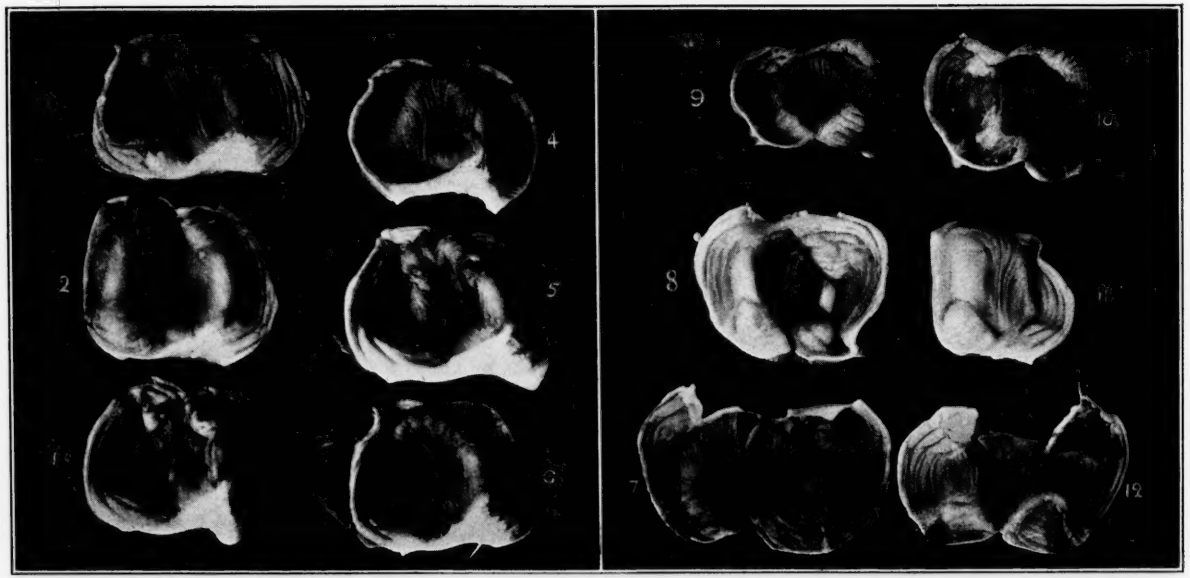
It is inconceivable that poultry pathologists in this country have not encountered cases of gizzard ulceration during the past few years, but no records of such cases appear to have been published.

The writer has noted typical lesions in a number of chicks received for *post-mortem* examination purposes at intervals during the past 5-6 years, but careful search for such erosions has only been made when examinations for more important pathological changes have been negative. Further, since their clinical significance was by no means clear, the matter did not receive serious attention until recently, when several outbreaks of disease in chicks were characterised by gizzard erosion as their most important *post-mortem* finding.

Since that time and during the past nine months records have been kept of the incidence of gizzard lesions (not associated with helminth infestations) in chicks and adult poultry of all species, and the widespread nature of erosion in the gizzards of chicks especially has been somewhat startling. Although the majority of cases have been seen in chicks aged 2-6 weeks reared intensively, in a few instances the affected chicks were being reared under hens.

In many cases the gizzard lesions were considered to be only of secondary importance to such maladies as coccidiosis (cæcal), rickets, pneumonia, lime-poisoning, and in turkeys blackhead — however, in other investigations the gizzard changes appeared to be of primary ætiological significance. Sometimes they were associated with delayed calcification of the metatarsal articulations, but in a few cases they were accompanied by thrush-like lesions of the lining membrane of the crop. In the majority of instances an advanced catarrhal exudate of the proventriculus was present, but this was presumably not identical with the "brownish or mucoid deposits" observed by Jungherr (1933a).

PLATE II



Gizzards 1, 2, 3, 5, 6, 9 and 10 show advanced necrotic lesions of the gizzard lining membrane. Gizzard 4 shows ulceration at the margin of the lining membrane at the gizzard-proventricular junction. Gizzard 8 has had its lining membrane stripped (specimen No. 7). Note in gizzard No. 8 the large central area of hæmorrhage. Gizzard No. 11 has also had its membrane stripped (specimen No. 12). In this instance the hæmorrhage can be noted enclosed in the gizzard membrane—bottom left-hand corner. Advanced ulceration will also be noticed top right-hand corner.

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Gizzard erosion and roughening has also been noted in adult poultry, notably in battery hens suffering from tuberculosis.

Ætiology

That this may be more complex than some workers are agreed is clear from a study of the available literature and present experiments, and although from American sources it is generally agreed that the primary factor is dietetic, its chemical constitution is still unknown. Almquist and Stokstad (1937) believe the gizzard factor to be fat soluble, but it is not considered to be identical with any of the known vitamins, whereas Bird, Kline, Elvehjem, Hart and Halpin (1936) previously reported that the anti-gizzard erosion factor was insoluble in ether. These workers associated it with the alkali-soluble acid precipitable proteins in the fractionation of lung tissue—pork liver and kidney were also excellent sources, and oats, wheat bran and middlings were superior to whole wheat and maize.

Since Jungherr (1935) reported that he had associated thrush of mycotic origin with gizzard ulcers, and because many of the foodstuffs used for poultry are liable to mould contamination, the possibility that gizzard ulceration is often of fungal origin must also be considered.

Also, one cannot exclude mechanical irritation—e.g., by cut wheat straw (bedding) or flint grit—as a cause for gizzard ulceration, because under intensive conditions of rearing particularly, an impaction or semi-impaction of the gizzard by grit is of fairly common occurrence, as is the finding of large quantities of bedding in the stomach.

Gizzard Erosion

The following are the most important pathological changes observed:

(1) Hæmorrhages at the junction between the gizzard proper and the proventriculus.

(2) Roughening and pigmentation of the horny layer.

(3) Exfoliation.

(4) Areas of necrosis of the horny layer.

(5) Gizzard erosion or ulceration.

(6) Ulceration of the secretory layer.

(7) Hæmorrhages within or below the horny layer.

(1) *The Junction between the Gizzard and Proventriculus.*—This area often shows the first pathological changes in the form of patechial hæmorrhages, notably at the junction with the gizzard membrane (the cardiac portion of the gizzard). These may be fine and few or multiple and aggregate, later to be followed by typical erosion lesions, which at times are quite independent of any seen in the gizzard proper.

(2) *Roughening and Pigmentation.*—In the absence of disease changes at the proventricular-gizzard junction, the first alteration from normal is a

roughening of the horny layer, i.e., of that surface normally in contact with food. This is due in part to the presence of additional though unorganised grooves or furrows, many intersecting with one another along the normal gizzard ridges. The pigmentation is characteristic and consists of the "deposit" of a bright orange-brown pigment within the superficial layers of the horny exudate, generally in the grooves concerned and not on the ridges. This is especially well seen in chicks fed on mashes containing yeast, and indeed might almost be considered to be a specific feature of this ingredient for chicks reared intensively.

(3) *Exfoliation.*—Should the roughening process continue it is followed usually by one of exfoliation. At first this consists merely of the shedding of small linear areas of the gizzard lining as though the consecutive layers of the horny exudate had failed to unite properly, and as a result of this disorganised secretion desquamation occurs more rapidly than normal, but essentially in linear formation.

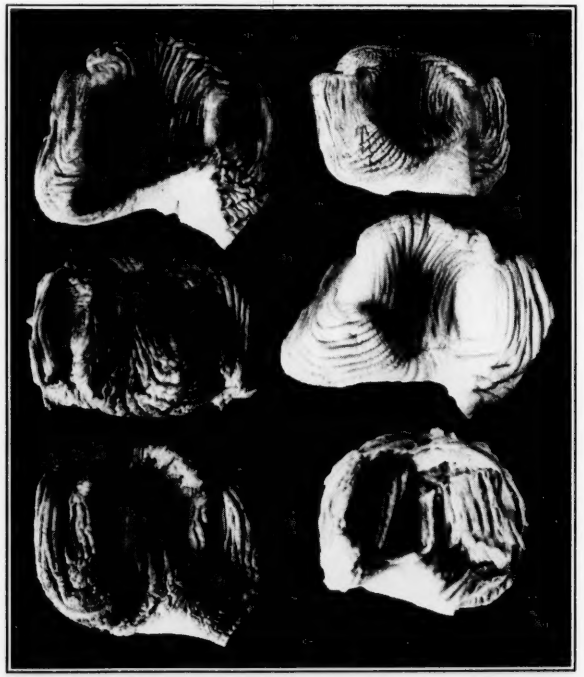
This is especially true of the keratohyalin layer adjacent to an eroded area, and confirms Almquist's and Stokstad's (1937) description: "The lining near the erosion is frayed and loosened in most cases, and may be brown or black coloured. The unaffected lining is usually quite coarsely ridged."

In a proportion of cases large areas of the horny layer become loosened, portions of which break off possibly to involve one-fifth of the whole membrane. Pigmentation of hæmorrhagic origin is not uncommon in such cases.

(4) *Areas of Necrosis.*—Strictly speaking, it is doubtful whether one can use the term necrosis to a secretion or exudate, but the clinical appearance is typical of what one would expect with a part which is "dead." It may therefore be visualised as a *pre-ulceration* stage, for there is little doubt that as soon as such an area sloughs the typical erosion lesion is then seen. The "necrotic" area appears dull and darker than the surrounding portions of the horny layer, sometimes better seen if the whole membrane is stripped off and held to the light. Occasionally with the stripping process the necrotic portion will remain adherent to the mucous membrane.

(5 and 6) *Gizzard Erosion and Ulceration.*—Although it is doubtful whether the lesion to be described and which characterises the disease process can be classed as an ulcer, it is also clear that there is no evidence to show whether the area concerned has been eroded away. Primarily an affection of the horny membrane (which presumably is lifeless), it is probably untrue to ascribe to it pathological features associated with death of the part, i.e., ulceration and necrosis—yet the clinical appearance of the part is typical of an "ulcer." It is depressed, irregular in outline and, although no opportunity has been available for histological examinations, the base of the eroded area is different in colour from the surrounding more healthy lining membrane—a feature probably associated with cell debris and blood pigments.

PLATE III



Figs. (Gizzards) 1 and 2 show advanced roughening. They are from adult poultry. Fig. 3 shows commencing ulcers at the proventriculus-gizzard junction. Fig. 4 shows moderate roughening and cracking—at the edges. Gizzard 5 is normal for an adult (hen), and Gizzard 6 demonstrates exfoliation.

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PLATE IV

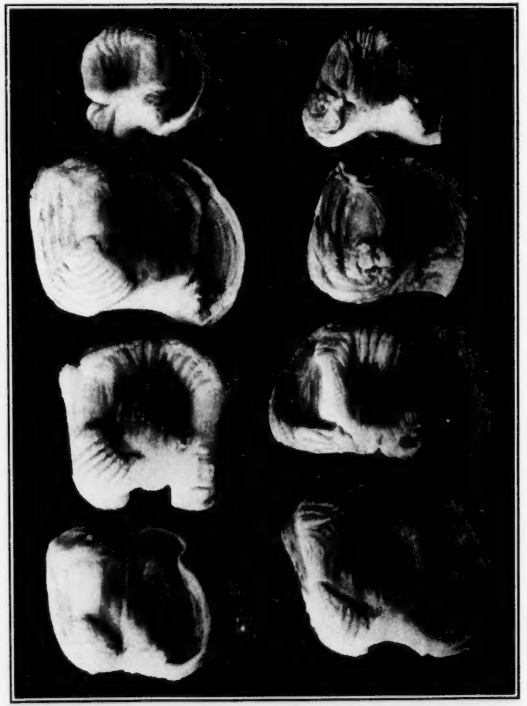

Fig. 1—normal gizzard. Fig. 2—small ulcer. Figs. 4 and 6—pre-ulceration. Figs. 5 and 7—exfoliation.

In the majority of instances, although the ulcer may appear deep, active and extensive (into the muscular layers), stripping of the horny layer will show that the naked eye changes are limited to this part. In contrast with Almquist and Stokstad, the writer has never observed lesions " severe enough to penetrate the muscular gizzard walls." The ulcers are very deceptive and may appear very deep indeed, yet they " come off " with the horny membrane.

As described under the paragraph dealing with the gizzard in health, the attachment of this membrane to the underlying coat is by means of numerous, short, pale villus-like processes. These, therefore, project into, and may be firmly adherent to, the soft, shallow, velvety secretory layer resting on the tough, white, fibrous submucosa. In a typically affected gizzard the soft and delicate secretory membrane will also appear eroded, but in no case has this been observed to penetrate through the sub-mucous coat to the muscle layer proper.

The ulcers concerned may be small and only the size of a pin's head, or some ten or more square millimetres in area. As pointed out by Almquist and Stokstad, " many are at the cardiac end of the gizzard," but few portions of the stomach appear immune to ulceration. The ab-oral end of the gizzard compartment often contains ulcers, and some may also be found at the gizzard exit to the duodenum.

Many of the smaller ulcers are somewhat triangular in outline, with sharply defined edges suggestive of a lesion due to laceration by sharp flint grit. Indeed, this appeared to be a possible cause for such cases until numerous chicks were found to be affected in batteries where no such sharp grit was supplied.

(7) *Hæmorrhages.*—Blood may be found embedded in the horny membrane or underneath it, but it is still uncertain whether these hæmorrhages are relayed to a co-existing deficiency of vitamin K, or whether they are a specific feature of gizzard erosion. Such extravasated blood within the secreted layers of the horny membrane probably accounts for some of the pigmented dark areas seen in the pre-ulcerous lesions.

Gizzard erosion can be seen to fall into three phases, thus:

The *first phase* is characterised by a distinct roughening of the lining membrane, due to a cracking of the gizzard lining, so that additional longitudinal grooves and ridges appear. (It is an easy matter to assess the degree of roughening, for many gizzards show advanced lesions of this type with little or no ulceration present.) Closely associated with the roughened linear areas of the gizzard, there is the characteristic pale (orange-brown) pigmentation seen when the mash fed contains yeast. If the mash contains alfalfa or grass, a green pigmentation of the gizzard will be noted.

In the *second phase,* actual " ulcers " appear, many are at the cardia, but all portions of the stomach may be affected. Occasionally portions of grit or cut straw (bedding material) will be found embedded in the ulcer.

In a few instances *small* ulcers will be present, but the gizzard lining as a whole will appear healthy and free from roughening. Such cases are not common. It is also true to suggest that in the majority of cases the degree of roughening is greater than the degree of ulceration. Associated lesions may be found involving the mucous membrane of the digestive tract where the proventriculus joins the gizzard. At this site there are no naked eye glands comparable to those of the proventriculus, nor is it covered by a horny lining membrane, as is the gizzard proper. The lesions are small and usually multiple, but always in the early stages hæmorrhagic.

The appearance of the early ulcer is sometimes hæmorrhagic, due to the destructive process having involved the blood vessels of the underlying secretory membrane, but in advanced lesions the centre of the ulcer consists of greyish cellular deposit with a clearly defined margin. If it is progressive its edges will often be hæmorrhagic.

The *third phase* is the most advanced stage of the disease, and is characterised by gross pathological changes, so that few normal features exist. The whole of the lining membrane is roughened, there are large areas of necrosis and numerous extensive ulcers, whose character is best determined by stripping off the horny membrane and examining the deeper strata. Exfoliation may be widespread, and gross changes may be noted at the gizzard-proventricular junction.

Chick Experiments

A number of coccidiosis experiments were commenced during the summer of 1938 and continued this year. Examination of some of the chicks showed that gizzard erosion was common to many of those reared intensively. Later experiments designed to ascertain whether a proprietary mash was responsible for a certain outbreak of rickets also showed that chicks reared intensively on the suspected as well as the control mash exhibited a high incidence of gizzard erosion. The mashes concerned were:

	Standard Mash.	Proprietary Mash C.
	%	%
Bran	20	14
Weatings	45	23
Maize Meal	15	33
S.G.O.	10	5
Fish Meal	6	7
Linseed Meal	—	3
Dried Skim Milk	4	7
Yeast	—	3
Salt	½	¾
Ground Limestone ...	—	2¼
C.L.O.	1	2

Next, 300 chicks were taken and divided into four groups, three of which were examined concerning the incidence of gizzard erosion. To the standard mash was added limestone grit in one case, and a concentrate of vitamin A in the second. In this latter case, instead of using 1 per cent. C.L.O., a fortified liver oil was used containing 20,000 I.U.A./gramme. It was incorporated in the mash the day before use. The results were as follows:

	Standard Mash.	Standard Mash and Limestone Grit.	Standard Mash and Vitamin A Concentrate.
Average + signs for roughening ...	0.45	0.75	2.00
Average + signs for ulceration ...	1.30	1.75	1.40
Chicks showing crop lesions	2	2	5
Average weight at 6 weeks (ounces) ...	13.60	14.40	12.00
Number of chicks examined	7	8	13

In the experiments just described, out of 28 chicks examined, three only were found free of gizzard erosions, therefore a further group of chicks was taken and divided into four batches, with 50 in each, and the pens were arranged as follows:

Pen 1 = Standard mash + 5 per cent. proprietary supplement A.N.

Pen 2 = Standard mash + 5 per cent. yeast.

Pen 3 = Standard mash + 12½ per cent. alfalfa + 3 per cent. grass juice.

Pen 4 = Standard mash + 1½ per cent. vitaminised rice bran oil (R.B.O.).

The chicks were housed intensively, and the available labour was not skilled, so that losses from overheating were high during the first week, but thereafter they were about normal. The chicks were the cheapest obtainable (day-old sex-linked or Japanese sexed cockerels), at 15s. per 100. Blue-flame hovers were used, and the bedding was cut straw. Mash was fed dry and *ad lib.*, and no corn or grit was allowed. The chicks were hatched on May 25 and 12 days later three chicks from each pen were killed and examined. By the 18th day some 30 chicks had been examined as follows:

	Pen 1	Pen 2	Pen 3	Pen 4
Number of chicks	6	6	10	8
Gizzard roughening	2.1	3.1	0.95	2.1
Gizzard ulceration	0.6	2.6	0.65	0.44
% chicks free from gizzard erosion	66%	16½%	30%	63%

At this stage it can be seen that the chicks in Pen 1 were not receiving much anti-gizzard erosion factor in their proprietary supplement, for although

only two of the six chicks showed actual gizzard erosions, the characteristic roughening was present in them all. Four chicks in Pen 2 showed extensive ulceration and two others advanced roughening, indicating that rather than protecting against erosion, yeast would appear to accentuate the condition.

Although only three of the ten chicks in Pen 3 were free of ulcers, there was only one chick which showed advanced lesions, and, in fact, this pen was definitely the best of the four concerned. The last pen did not show many cases of actual gizzard ulceration, but all except one chick had very "rough" gizzards.

Forty more chicks were killed and examined during the succeeding four days, with results as follows:

	Pen 1	Pen 2	Pen 3	Pen 4
Number of chicks examined	10	10	8	12
Gizzard roughening	1.45	3.2	1.63	2.5
Gizzard ulceration	0.30	2.3	0.70	0.67
% chicks free of erosions	70%	10%	37.5%	50%
Average body weight ...	5.2 oz.	4.6 oz.	3.8 oz.	4.2 oz.

Thus Pen 2 remains the worst where erosion is concerned, but Pen 1 appears to have improved and to be somewhat superior to that receiving the grass juice supplement and alfalfa.

It was learnt at this stage that, owing to an error on the part of the poultry attendant, the chicks in Pen 4 were actually receiving twice the quantity of R.B.O. prescribed. As a result the chicks were doing badly, with a tendency to scour and the leg bone calcification was poor also. The oil was therefore stopped on June 13. During the next three days the roughening of the gizzard appeared to increase about 50 per cent. in five chicks examined from this pen.

In connection with Pen 3, seven chicks died suddenly overnight from peracute cæcal coccidiosis, and as a number of the others were scouring the quantity of dried grass powder was reduced by half. A few days later all the supplements to the standard ration were done away with and from then till the end of the experiment the chicks in all pens received plain mash. All the remaining chicks were killed when approximately one month old, and the results were as follows:

	No. of chicks examined.	Age (days).	Gizzard roughening.	Gizzard ulceration.	% of chicks free of ulcers.
Pen 1	32	25	2.70	1.60	48
Pen 2	28	28	2.17	0.90	25
Pen 3	25	27	1.90	0.70	26
Pen 4	20	36	1.45	0.30	75

Discussion

These results are of considerable interest because they show that the supplement " A.N." did appear to be giving some protection against ulceration as noted when it was omitted from the ration. This was contrary to the impression gained earlier in the experiment. The improvement in Pen 2 following the withdrawal of the yeast suggests that this ingredient may be inhibitory to the gizzard erosion factor. If this is correct it will have a bearing no doubt on the result obtained by workers using simplified rations. In the case of Pen 3, although the incidence of both roughening and ulceration was not as high as with most of the other chicks, it proved that even 12½ per cent. alfalfa with dried grass juice failed to prevent ulceration, so that poultrymen cannot rely on these ingredients for protective purposes. In future experiments it will obviously be necessary to try to discover whether dried English grass is superior in this respect, and whether the gizzard factor is related in any way to vitamin C.

It was unfortunate that the quantity of rice bran oil fed was excessive, for this will have marred the results, and in view of the fact that after it was withdrawn the lesions receded considerably, so much so 75 per cent. of the chicks were found free from actual ulceration, a repeat experiment using differing quantities of the oil is indicated.

Throughout the experiments it was clear that the erosions encountered were typical of those described in American literature, but it was also evident that erosion as such only represents part of the syndrome associated with the preventive factor. In this respect the hæmorrhages noted require further investigation to prove whether they are related in any way to vitamins K and C. To conclude that they were associated with a deficiency of the fat soluble vitamin would be to refute the accepted American opinion that the " hæmorrhagic syndrome " does not occur under practical conditions, but only on simplified diets. The standard ration in question has been used commercially with satisfaction for a number of years and cannot therefore be considered as " simplified."

Taking field observations into account, there would seem to be no foundation for the belief that mechanical causes for ulceration play any real part in the ætiology of the condition, but the question of mycotic infections is not as clear. Thrush-like lesions involving the crop were not uncommon early in the experiments, for nine out of 28 chicks were thus affected. Examinations of later chicks showed far fewer cases until finally in the last 116 chicks examined (aged 25-36 days) there were no cases recorded.

A study of the following table will show that chicks suffering from gizzard erosion were not underweight, in fact some of the worst affected birds were heavier than the average. Further, the weight of the gizzard

itself was not affected by the absence of the erosion preventive factor, thus :

	Average weight (ozs.).	Ratio of gizzard to total body weight.	G/body ratio of chicks severely affected by erosions.	Weight of chicks severely affected by erosions (ozs.).	Age (days).	Number of chicks examined.
Pen 1 ...	7	1 : 19	1 : 18.7	7¼	27	32
Pen 2 ...	8	1 : 17.9	1 : 17.8	8¼	29½	28

Bacteriological examinations for fungi were negative in all cases where the gizzard was examined, and also in most cases in which there were typical thrush-like lesions of the crop, but in a few cases fungi were recovered from these latter lesions.

Conclusions

(1) That gizzard erosion is probably of widespread occurrence throughout Great Britain in numbers of intensively reared chicks, aged 2-8 weeks.

(2) That the standard mash used successfully for the production of table poultry did not give protection against gizzard erosion when used intensively under the conditions of the experiment.

(3) That a ration containing 20 per cent. bran, 12½ per cent. alfalfa and 3 per cent. dried grass powder did not protect against gizzard erosion, somewhat contrary to the results of Almquist and Stokstad.

(4) That dried yeast appeared to accentuate the condition.

(5) That gizzard erosion is only one of the findings to be noted *post-mortem* associated with a deficiency of the nutritive factor concerned. Additional gizzard features are hæmorrhages, " roughening," pigmentation, exfoliation and necrosis.

(6) That the factor concerned appears necessary for the healthy functioning of the tubular glands in the *tunica propria.* of the gizzard. If deficient the horny secretion will become disorganised, with or without hæmorrhages in its substance.

(7) That only a proportion of chicks in any given batch will be affected, presumably due to varying amounts of the anti-gizzard erosion factor having been inherited via the yolk sac.

(8) That there is no co-relation between body weight, gizzard weight, gizzard weight/body weight ratio and the number or degree of lesions observed.

(9) That although some cases of erosion may be associated with mechanical causes and others related to fungous infections of the crop (Thrush), the vast majority are due solely to an absence or inhibition of the specific nutritional gizzard erosion preventive factor.

(10) That no evidence was obtained to show whether the gizzard lesions observed did affect the well-being of affected chicks relative to coccidiosis.

(11) That the whole problem requires careful investigation to decide its importance and significance for the practical poultry farmer.

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Since the above article was written, the writer has received a reprint from Dr. Almquist of his article on "The Influence of Bile on Erosions of the Chick Gizzard Lining" (Almquist, H. J., and Mechhi, E. [1938], *J. Biol. Chem., 126,* No. 1, November, 407-412). These authors suggest that bile normally finds its way into the gizzard at intervals, and as such, cholic acid forms an integral part of the gizzard lining, and therefore a deficiency of bile or of cholic acid in the chick leads to erosions of the lining. They show that cholic acid is an effective dietary supplement in the cure or prevention of erosion in the gizzard lining, and that dehydrocholic acid is almost equally effective, whereas desoxycholic acid is comparatively ineffective.

RAPID DIAGNOSIS OF CANINE DISTEMPER*

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EARLY and accurate diagnosis is an absolute prerequisite to effective measures against canine distemper in kennels and on fur animal ranches. For effective control of distemper, diagnosis should not only be early but it must also be certain.

* Acknowledgment is made to the Fromm Laboratories, Grafton, Wisconsin, for materials and facilities used in developing the rapid smear technique for distemper diagnosis.
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Clinical appearance and gross necropsy findings in this disease, while usually considered diagnostic, are sometimes misleading. In our experience with minks and foxes we have found that a number of diseases may simulate distemper; moreover, atypical cases of distemper may be mistaken for a wide variety of other conditions. Consequently, neither clinical nor pathological appearances are adequate as a practical basis for the diagnosis of distemper in fur-bearing animals.

Since the work of Laidlaw and Dunkin[1] demonstrated that the virus of canine distemper is highly virulent for the ferret, many investigators have used the susceptibility of this animal as a means of diagnosis. Producing the characteristic symptoms and finding of distemper in ferrets by the injection of tissue rules out practically all conditions which might be confused with distemper. However, the delay of two or three weeks entailed in a test for ferret susceptibility is much too costly when one is dealing with a highly infectious disease such as distemper.

During the past thirty years occasional reports on the inclusion bodies of distemper have been made, principally in European literature. Many of these[2, 3, 4, 5] were concerned with the presence or absence of inclusion bodies in the brain only, but others[6, 7] have described inclusion bodies in a number of tissues such as bronchial, conjunctival, and intestinal epithelium, and lymph nodes.

More recently, in this country, De Monbreun[8] has described the inclusion bodies he found in a number of dogs with natural and experimental infections. Unfortunately, this investigator failed to recognise the presence of what apparently was the virus of epizootic fox encephalitis[9, 10] together with that of canine distemper in one dog with a natural infection and in others experimentally infected; and, as a result, his report described the inclusion bodies of fox encephalitis as typical of the canine distemper virus.

A detailed description of the morphology and comparative distribution of distemper inclusions as we have found them in an extensive study of foxes, minks, ferrets and dogs is now in press.[11]

The characteristic inclusion bodies of distemper are cytoplasmic, but some intranuclear inclusions, also, are usually present. Both types are found principally in the epithelium, particularly that which lines passageways of the body such as the urinary tract, bronchial tree, gastro-intestinal tract and ducts of glandular organs, notably the bile ducts, pancreatic ducts and ducts of the salivary glands. The epithelial cells of the adrenal and the reticulo-endothelial cells of lymph nodes and spleen may also contain inclusion bodies of distemper. This distribution of inclusion bodies is peculiar to distemper. No other virus disease of canines and fur-bearing animals is known to produce inclusions both in cells of surface epithelium throughout the body and in the other sites noted. In fox encephalitis, the disease most apt to be confused with distemper, the inclusion bodies are always intranuclear and are found

principally in cells of the vascular endothelium, occasionally in lymph nodes and in hepatic cord cells, but never in bile ducts nor in other surface epithelial cells where the inclusions of distemper occur. An accurate diagnosis of distemper may be obtained by the demonstration of the inclusion bodies, utilising ordinary paraffin sections made of formalin-fixed tissue and stained with hematoxylin and eosin. By this method, the time required to establish a diagnosis of distemper is shortened from the several weeks necessary for test by ferret inoculation to a few days; and in the case of foxes and dogs the result is much more dependable.

We have now devised a rapid method of distemper diagnosis by which the inclusions typical of the disease may be demonstrated within an hour. This method is applicable principally to foxes and minks which have died of the disease or which have been killed late in the course of the infection when the inclusion bodies are most highly developed. As characteristic inclusion bodies are present in the transitional epithelium of the urinary tract in more than 90 per cent. of fatal cases of distemper in foxes and minks, smears containing these cells usually show inclusions, and examination of two or three animals from the same outbreak yields a positive diagnosis if distemper is present.

For rapid diagnosis, scrapings are gently made with a scalpel from the lining of the bladder, emulsified in a drop of Mayer's albumin fixative[12] on a clean glass slide, and spread into a smear. It is preferable to allow the slide to stand half an hour at room temperature, but one may proceed immediately with the staining. If the smear is prepared from formalinised tissue, the surface of the bladder should first be blotted with absorbent paper to remove excess moisture. The smear is then prepared as in the case of fresh tissue except that before staining it should be fixed with methyl alcohol in order to decrease the tendency of formalinised cells to wash off the slide in staining.

While a variety of stains may be used successfully, we have usually employed aqueous hematoxylin and eosin. Harris' hematoxylin is prepared according to the formula given by Mallory and Wright.[13] The "yellowish eosin" marketed by the Harmer Laboratories Company, of Lansdowne, Pennsylvania, has been entirely satisfactory. One gram is dissolved in 150 cubic centimetres of distilled water and the solution is filtered before being used. Our staining schedule is as follows:

1. Hematoxylin: 5 minutes, maximum; 2 minutes, usually optimum time.
2. Tap water, 10-15 minutes (5 minutes satisfactory if cells are a deep purple).
3. Acid alcohol, 1 or 2 dips.
4. Tap water, as above.
5. Eosin, 1 dip.

6. Distilled water, 1 or 2 dips.
7. Eighty per cent. ethyl alcohol, 1 dip.
8. Ninety-five per cent. ethyl alcohol, 1 dip.
9. First absolute alcohol, 30 seconds.
10. Second absolute alcohol, 30 seconds.
11. Dunham's solution, 5 minutes.
12. First xylol, 3 to 5 minutes.
13. Second xylol, 3 to 5 minutes.
14. Coverslip.

Variations in the timing are made as indicated by the results. Inclusion bodies are most clearly visible if the tissue is slightly overstained with eosin and understained with hematoxylin.

We have prepared and examined approximately 600 bladder smears, of which about 30 per cent. were positive preparations. Some of the animals from which bladders were taken had been killed when sick and others were allowed to die. Some of the carcasses were fresh, other autolysed. That bladder smears constitute a reliable basis for diagnosis is indicated by the fact that we have in no instance been misled into making an unqualified diagnosis of distemper from the smear and subsequently found that distemper was not present. However, in a small proportion of the smears, globules of acidophilic cytoplasm which might be confusing have developed from autolysis of the cells. In such cases, paraffin sections must be made in order to determine whether or not distemper is present.

If an animal is killed when sick but not moribund, the probability of finding distemper inclusions in the bladder or in sections of other organs is greatly reduced. It should be emphasised that animals which have died of the disease are far superior to those killed when sick as far as diagnostic purposes are concerned, for the inclusion bodies of distemper develop most fully late in the course of the disease.

In addition to hematoxylin and eosin, we have used several differential smears, and found them just as satisfactory for smears as for paraffin sections of tissues containing inclusion bodies. The Giemsa stain, for example, shows the inclusions very clearly, and at least in some instances seems to distinguish in the inclusion two substances, an acidophilic component which stains red, and an apparently basophilic component which stains a deep blue-black. A given inclusion may appear entirely one colour or the other, but usually contains both colours, in almost any conceivable ratio.

Broadhurst, MacLean and Saurino,[14] in January, 1938, reported on nasal inclusion bodies in dogs ill with distemper, or convalescent from distemper as demonstrated by staining with nigrosin. We have stained bladder smears with a similar stain, Congo red. This, like nigrosin, is used as a negative stain for bacteria, but for inclusion bodies it acts as a positive stain, making them appear very dark, much more so than the cytoplasm by which

they are surrounded. It is impossible to compare the tinctorial affinities of structures stained only with nigrosin or Congo red with those of inclusion bodies stained with hematoxylin and eosin. The nigrosin-stained inclusions described by Broadhurst, MacLean and Saurino were only ½ to 2 microns in diameter, whereas in our experience, as well as that of others mentioned previously, distemper inclusions vary from this small size up to 15 or 20 microns in diameter. For the present, it seems impossible to determine whether or not the structures described by Broadhurst and her co-workers are of the same nature as those we have found in smears and in tissue sections.

The inclusion bodies of distemper occur in many organs other than the bladder and, as might be expected, they may be demonstrated by the smear technique in several of these organs. When the bladder is unsuitable, or when it is anticipated that few inclusions will be found in a given animal, we make smears of the epithelium lining the trachea and nasal cavities. Typical distemper inclusions of various sizes and shapes, often with the characteristic vacuolated internal structure, are clearly seen in the cytoplasm of the ciliated columnar cells of these preparations. In short, we have found the smear technique satisfactory for any type of cell which can be readily transferred to a slide. The cytological details seen in smears are equal to, if not superior to, those found in routine paraffin sections.

Summary

1. An accurate diagnosis of distemper may be made by recognition of the specific inclusion bodies stained in paraffin sections.

2. A rapid method of diagnosing distemper is described, in which the inclusions are stained in smears from the bladder epithelium.

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Abstracts

FILTERABLE VIRUSES*

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It is notoriously difficult to assess the value of contemporaneous research, but among the many remarkable discoveries of recent times, those relating to the part played by filterable viruses in the causation of disease must occupy a very prominent place in the history of medicine. Apart from their great economic importance, filterable viruses also have a much wider interest since they are linked up with the problem of what is meant by a living organism.

There is no necessity to enter into a history of the subject, beyond mentioning that the first clear recognition of the existence of agents of infection, invisible with the highest powers of the microscope, only began in 1892, when a Russian botanist, Ivanovski, showed that the causative agent of mosaic disease of the tobacco plant could pass through porcelain filters which arrested bacteria. Little notice was taken of this discovery until seven years later when Beijerinck confirmed and extended these observations, and about the same time Löffler and Frosch showed that the infection of foot-and-mouth disease was similarly capable of passing through filters. It will be seen, therefore, that the study of viruses falls almost entirely within the present century, and most of the work on them into the last twenty years.

It is very difficult to formulate a definition for filterable viruses to cover any hypothetical disease-producing substance, but I will anticipate matters by stating that I regard filterable viruses as living organisms, which in all stages of their life remain below the limit of the present power of microscopic visibility; in other words, organisms whose dimensions in any direction are less than 0.2 micron, the present limit of resolution with visible light. Our first problem, therefore, is to decide what to include in the group.

A definition of this nature at once excludes such disease agents as *Rickettsia,* the organism of pleuropneumonia of cattle, and even spirochætes, many of which are filterable in the ordinary sense of the term—at least, during some stage in their life-history—but all possessing visible stages. On this assumption that viruses are living agents, what might one expect to be able to find in organisms below the limit of microscopic visibility?

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I. They should be particulate and each virus should have a specific size.

II. They should have the power of indefinite reproduction by self-synthesis (growth).

III. They should show some evidence of vitality by producing evidence of metabolism apart from the cells in which they live, and also destruction by chemical or physical agents which are inimical to life.

IV. While maintaining antigenic individuality they should show variability.

I. If we consider the first of these, viz., the particulate nature of viruses, this may be considered to have been demonstrated by the combined methods of graded filtration and microscopy, especially by the use of ultra-violet light photography.

Using these methods, as well as by high-speed centrifugalisation, it has been shown that the viruses occurring in animals and plants have definite sizes ranging from those just below the limit of ordinary microscopic visibility down to those only two or three times the size of serum proteins and oxyhæmoglobin.

Although these results prove the existence of virus particles of specific sizes they leave untouched the argument sometimes advanced that viruses are merely developmental stages of larger forms. This view, however, may be excluded by means of graded filtration experiments. By repeated washing of the residue on collodion filters it is possible to separate viruses of different sizes in a way which would obviously be impossible if the smaller ones had larger stages. Of course, one can assume that these latter only occur under specific conditions, such as in another host, a view which is difficult to include, but I may say at once that with most of the viruses generally accepted as such, no one has yet succeeded in demonstrating any significantly larger stages.

It is necessary at this point to call attention to the extremely small size of some of these virus particles (e.g., foot-and-mouth disease, 8-12 microns), which is within appreciable distance of the size of serum proteins and oxyhæmoglobin (3-5 microns).* With reference to shape, those viruses that have been studied by ultra-violet microscopy all seem to be roughly spherical, and there is no evidence in support of the existence of filamentous forms. The question as to whether these particles represent virus alone, or are merely granules with adsorbed virus on the surface, may also be considered to have been decided by methods of elution, apart from the fact that such a hypothesis involves the further assumption that each virus was selectively adsorbed by tissue particles of a constant size.

Summing up the results of our first characteristic we may say that recent work has shown that viruses consist of particles; each virus has particles of a

* Some idea of their minute size may be gathered from the fact that 1,000,000,000,000 particles of the virus of foot-and-mouth disease would occupy less space than a pin's head.

specific size within the range of ordinary variation, and finally, that these particles would seem to be more or less spherical in shape. But in view of the extremely small size of some of them their organisation must be of the simplest. Why, therefore, should we regard these particles as living?

II. I think it will be generally admitted that the most characteristic feature of living matter is the power, under appropriate conditions, of indefinite multiplication. I may say at once that all viruses do seem to possess this property; e.g., the blood of a monkey, inoculated with yellow fever virus, three days later may contain as much as 1,000,000,000 units of virus per c.c. But this growth is under conditions which complicate the issue, namely, only in the presence of living cells, for in spite of statements to the contrary no very satisfactory evidence has yet been furnished of their multiplication in media devoid of any living tissue.

There is nothing peculiar, of course, in the fact of a parasitic organism being difficult to cultivate in the absence of the tissues of its host, and ultimately it may be possible to grow viruses in artificial media in the same way as many parasitic protozoa and bacteria are cultivated in the laboratory. Until this can be demonstrated beyond question, however, it is always possible for those who support the view that viruses are not living organisms to consider any multiplication of virus as a result of the perverted metabolism of the living cells in the medium. Such a view is held by some distinguished investigators in the case of the transmissible lysis of bacteria (bacteriophage) and also in the case of the filterable agent or agents associated with certain fowl tumours. Personally, I find it very difficult to conceive a non-living toxic principle acting on living cells in such a way as to cause these cells to produce yet more of the agents of their own destruction. Moreover, since many viruses are not restricted to one species of host, it is necessary to assume that the hypothetical toxic agent can attack cells of different species, and yet in each call forth the same response. Yellow fever virus, for example, can multiply in the tissues of man, many species of monkeys, hedgehogs, and certain rodents, and in tissue cultures will grow even in fowl tissues, yet in each case the same virus is produced. Apart from the difficulty of conceiving the same response from such diverse types of living cells, it is also necessary to imagine the living cells simultaneously reproducing the toxic agent and also the immune bodies against it.

In spite of the difficulty, therefore, of the apparent failure of viruses to propagate themselves in the absence of living cells, I think the available evidence supports the view that those which have been studied are so strictly parasitic in thir habits that the necessary conditions of their growth in artificial media have not yet been realised. I need hardly mention that there are many examples of larger parasitic animals and plants which agree with viruses in this respect.

Another point remains to be considered: are we to assume that all viruses

are parasitic? Certainly not; but the difficulties of recognising an invisible organism living saprophytically in a medium will be at once apparent. Mr. Barnard has obtained evidence in support of the view that such saprophytic viruses do exist in nature, for he has observed the multiplication of ultramicroscopic bodies in culture media that were bacteriologically sterile. However, much further work remains to be done on this important and very difficult problem, which may throw light on the nature of the filterable organic matter present in sea-water.

III. I now come to the question as to whether viruses perform any of the metabolic activities generally associated with living organisms, and their susceptibility to chemical and physical agencies, which are generally inimical to life.

Up to the present no satisfactory evidence has been advanced that viruses respire, or in fact have any metabolic activities apart from the host, but it must be admitted that the difficulties of recognising these activities in organisms of such extremely small size are very considerable. It is necessary, of course, to separate the virus from any other living matter, and when this was done in the case of bacteriophage, *Bacteriophagum intestinale*, Bronfenbrenner entirely failed to find any evidence of independent metabolic activity. Using a special micro-respirometer, he was unable to detect any CO_2 production by 10^{12} active units of bacteriophage during a period of 96 hours. Moreover, actively multiplying cultures with and without bacteriophage showed similar rates of respiration.

It has been calculated that the rate of respiration of a unit of phage must be at any rate 10,000 times less than that of bacterial spores, which seems to indicate that the phage does not respire at all. Blood containing the virus of fowl plague has been stated to respire at a different rate from normal blood, but such a result, if correct, would not necessarily indicate any metabolic activity of the virus, as it might be due to direct alterations of the blood.

These attempts to demonstrate an oxidative metabolism in extracts containing the virus separated from cells in which it grows may be regarded as premature; but certainly up to the present our evidence of the vitality of virus particles has only been obtained by a study of their behaviour after transmission to a host.

With reference to their susceptibility to chemical and physical agencies, viruses differ very widely in their properties, as might be expected from such a heterogeneous assemblage.

They are generally stated to be more resistant to glycerine than ordinary bacteria, but this is probably due to the fact that most viruses are very susceptible to conditions in autolysing tissues and glycerine acts as a desiccant and retards this autolysis. In the case of yellow fever the virus quickly deteriorates when kept in Ringer's solution or physiological saline, but this deterioration is

prevented by the addition of 10 per cent. normal human or rabbit serum, or even broth.

Many viruses will withstand desiccation, but in some cases only if the drying is carried out below freezing point, and the dried product kept under strictly anhydric conditions, either in a sealed tube or in a desiccator. Under these conditions many viruses will survive for long periods, at least five years, and whilst dry are more resistant to chemical or physical agencies.

Some viruses are incredibly resistant to chemical agencies. Extraction with chloroform, acetone, alcohol and toluol for 2-8 days does not inactivate dried Vaccinia; African Horse Sickness will withstand 3 per cent. phenol for 5-7 days at 0° C., though it is rapidly killed at higher temperatures. Most viruses are inactivated in a few minutes by temperatures of about 55° C. wet or 60° C. dry, but there is considerable variation in this respect.

It will be seen, therefore, that the first three postulates have been more or less fulfilled—perhaps rather less as far as the third category is concerned—and I now come to another characteristic of living organisms, viz., their antigenic individuality and power of variation.

IV. The maintenance of antigenic individuality irrespective of the tissue or animal species in which the virus is grown is a point of very great importance. If a human strain of *herpes* is adapted to the guinea-pig and an *anti-herpes* serum prepared from it, this serum will neutralise specifically not only guinea-pig strains of *herpes,* but also human and rabbit strains. Corresponding results are also obtained by the use of complement fixation.

Similar results have been demonstrated in the case of antivaccinia serum against the guinea-pig strain, which will react specifically with vaccinia of guinea-pig, rabbit and man. If filterable viruses are unorganised non-living agencies, their multiplication in living tissues must result from changes in the affected cells producing more of the agent which caused the initial change. We should expect an agent of this sort to bear the antigenic imprint of the animal species from which it arose. This is not the case, and to explain this absence we should have to assume that the virus was something in the nature of a haptene which, uniting with the cell degeneration products, gave them a new antigenic value, a virus specificity. A much more reasonable explanation of these facts is the view that viruses are independent living beings.

To prove the existence of variations in the virulence of any parasite is difficult, for one has to deal with two variables, the parasite itself and the host. The variation of the host may be expressed in many different ways: alterations in the conditions affecting the invasion of the host by the parasite; changes in the response of any protective mechanism, such as immune body formation; possible influence of concurrent infections, etc., etc. All these factors and many others have to be taken into account in assessing the significance of any variations in the severity of symptoms, or mortality, and this aspect of the

problem has to be approached statistically. But there is one type of variation that many viruses have been shown to undergo, viz., changes in the organ which they attack, which can definitely be confined to changes in the parasite itself. One of the most striking examples of a change in habit of this nature is shown by yellow fever virus. Normally this virus is viscerotropic, mainly attacking the liver, in which it produces certain characteristic changes, but if the virus is brought into intimate contact with nerve cells by intra-cerebral inoculation into mice, it may change its — shall I say — feeding habits and acquire the property of attacking nerve cells instead of hepatic cells. Such a virus, with affinities for the nervous system, is known as a neurotropic virus, and many viruses have been shown to be capable of acquiring this property. Neurotropic yellow fever has been maintained in serial passages from brain to brain for hundreds of generations without reverting to the type from which it arose, but recently Findlay and Clarke have shown that the reverse process is possible. After 182 passages in mice, neurotropic virus was inoculated into the liver of a rhesus monkey, and four to seven days later the liver, spleen and blood examined for the presence of yellow fever virus. If a susceptible animal is inoculated either subcutaneously or intraperitoneally with neurotropic virus, this very soon disappears from all parts of the body except the nervous system. But if such virus is inoculated into the liver it changes its predilection for nervous tissue and may be found in the liver, spleen and blood, and after a few passages reverts to the ordinary form, attacking mainly the liver and only exceptionally the nervous system.

The alteration in yellow fever virus from the viscerotropic to the neurotropic variety seems to be more of the nature of a fluctuation than a mutation, for intermediate stages occur between the two, and the reversal of the process under changed environmental conditions also supports this view.

Sometimes variant strains of viruses arise spontaneously, as in the disappearance from this country of smallpox and its replacement by the more benign alastrim. Generally, however, these variations have been produced artificially by repeated passage of the virus through the tissues of an animal only distantly related to the host. The best-known example is, of course, vaccinia virus, formed from the virus of smallpox, by passage through the calf and rabbit.

The relationship of these modified viruses to their parent strains is of considerable interest, but their new characters seem to be definitely a response to changed environmental conditions, and in this respect they resemble the larger animals and plants.

I would emphasise that the change from ordinary yellow fever virus to the neurotropic form is a gradual one connected by a series of intermediate stages. Moreover, all types produce cross-immunity, i.e., recovery from any one of them renders the host immune against all the other types.

Turning now to variations in pathogenicity we have to face the difficulty

of variations in the host, but it is hardly necessary to mention the well-known fact that epidemics of the same disease may vary in the symptoms produced. Influenza will at once occur to everyone, but since our knowledge of the ætiology of that disease is still in the experimental stage, I will again take yellow fever as an example.

Different epidemics, both in the old and new world, have been found to show extraordinary differences in mortality, ranging approximately from 5 to 90 per cent. The strain of yellow fever that I established in London in 1928 had been isolated from an African native who showed none of the typical symptoms of the disease, yet in the laboratory was found to be fully virulent, and was responsible for the death of Dr. Adrian Stokes. Shortly after obtaining the strain in this country, both I and my laboratory attendant had very mild attacks of fever without any characteristic symptoms except the development of immunity against the disease, and yet this same strain nearly two years later, after passage through monkeys for the intervening period, was found to be fully virulent and produced typical yellow fever infections.

In Africa the development of a method of diagnosis based on protection tests in mice has shown that yellow fever is very widespread, extending throughout Equatorial Africa from the West Coast even to the Anglo-Egyptian Sudan, yet this high incidence of immunity (in some villages up to 80 per cent. of those tested) may occur in districts from which no case of yellow fever has ever been recorded. Charles Nicolle considers that yellow fever is an example of a disease that is gradually dying out owing to loss of virulence, but, whatever the explanation, fluctuations in the pathogenicity of the virus certainly seem to have taken place.

Filterable viruses, therefore, in this property of variation and adaptation to environment strongly suggest analogies with animals and plants. In the case of bacteria it has long been known that they can be trained *in vitro* to ferment new compounds. The virulence of pneumococcus may be increased by repeated transfers in lung medium and decreased by similar transfers in spleen medium (Felton), and Fildes considers that the enzymatic constitution of a bacterium is determined by the substrate on which it lives.

You may think that I have selected types of virus about which there is little doubt of their living nature, but I would point out that yellow fever virus is a very typical one of rather small size, the particles being only 17 to 28 microns in diameter, approximately six times the diameter of oxyhæmoglobin molecules.

I hope that these notes on the subject will have convinced you that in viruses we are dealing with living agents—not necessarily bacteria—but minute *Protista,* a term which may very aptly be used for organisms that have certainly not developed any marked characteristics of either the animal or vegetable kingdom.

The diseases caused by insect-transmitted viruses may in some of their

properties recall protozoal infections. Also many virus diseases exhibit the carrier conditions, whereby the host may carry the infection for long periods without showing any signs of disease, another feature more commonly associated with protozoal than bacterial infections. I have no intention, however, of supporting a protozoal as against a bacterial nature for viruses, except to point out the necessity of regarding these organisms as not yet sufficiently differentiated to show the characteristics generally associated with one or other of these groups of living beings. Logically, one is bound to admit the existence of stages in the evolution of living organisms from non-living matter, but apart from their excessively small size, most of the viruses that have been sufficiently studied seem to have already attained the more important characteristics of life.

NICOTINIC ACID

NICOTINIC acid, recently isolated from liver, is reported to be highly effective, in doses of 1.5 mg. per kilogram of body weight, in curing black-tongue in dogs and "harmless, whether administered orally, intramuscularly or intravenously" (Margolis, Margolis and Smith, quoted by Smith and Co-workers, *J. A. M. A.*, 109 (25), 1937, 2054-55).

Smith and co-workers report successful treatment of a case of human pellagra with nicotinic acid. Doses of 60 mg. were given daily for 12 days.

Nicotinic acid is very cheap and this treatment costs less than 10 cents.

"If subsequent investigations prove that nicotinic acid is the P-P factor of Goldberger . . . it is possible that it could be mixed with table salt and sold in areas where pellagra is endemic, similarly to the distribution of 'iodised' salt in districts in which goitre is prevalent."—*N. Amer. Veter.*, June, 1938.

FURTHER TESTS WITH THE RIEMS VACCINE AGAINST F.-AND-M. DISEASE *

By DR. HAAN, of Frankfort, and DR. MAAS, of Soldin

1. RIEMS vaccine in general inoculation is harmless, it causes no infection.

2. Subsequent outbreaks after cattle virus vaccination occurred in 8 days and after culture virus in 15 days. In ring inoculation in disease areas 35 per cent. in the worst outbreaks, but in the unaffected areas only 3 per cent.

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* *B.T.W.*, March 17, No. 11.

3. Immunity followed quickly and regularly in vaccination with virus; already in 3 to 5 days after vaccination immunity is so far developed that a great number of the vaccinated animals are immune against contact infection. All inoculated cattle appear to be immune after 8 to 10 days.

After inoculation with alternated virus development of immunity is not so regular, nor is it with culture virus vaccine, and outbreaks occurred 15 days after inoculation.

4. In areas where the cattle virus vaccine was used 95 per cent. of the animals were immune after 8 to 9 months.

5. The results of active immunisation in Soldin, Arnswalde and Luckau showed that the plague could be brought to a standstill and an advancing spread be checked.

SILVER FOXES AS SOURCE OF INFECTION WITH TRICHOPHYTIA IN MAN*

By PROF. N. DANBULT

At the dermatological clinic of the University of Oslo we have had the opportunity of examining a number of cases of Trichophytia among people engaged in the raising of silver foxes. We have also made examinations of silver foxes on a large fox farm where skin affections of this type had occurred frequently among the personnel.

A number of silver foxes on this farm showed slight changes of the pelt, especially on the snout, ears and paws. The hairs were discoloured, partly lost, and the underlying skin was slightly scaly. Fungus mycelium in abundance was found in the hairs and scales and cultures showed growth of Trichophyton gypseum asteroides. The same fungus was cultivated from some of the personnel of the farm.

In Norway the silver fox industry has become very important. In 1936 it was estimated that there were about 18,000 farms with about 190,000 foxes. The animals on these farms live under the most hygienic conditions so that there is little opportunity for Trichophytia to become widespread. Nevertheless, one should bear in mind the possibility of this animal as a source of infection with Trichophytia in man.

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* *Norsk V. Tdskrift.*, March, 1939.

THE ECONOMICS OF PEANUT AND MAIZE PRODUCTION IN THE SPRINGBOK FLATS, NORTHERN TRANSVAAL*

By F. R. TOMLINSON, Ph.D., D.Sc. (Agric.)
Division of Economics and Markets.

In this study the organisation of peanut-producing farms on the Springbok Flats has been analysed from the point of view of land-use and capital investment. The profitability of the farms and the main factors influencing financial success have been determined in detail. In addition thereto the costs of production and profits in the main crop enterprises, peanuts and maize, have been analysed. The study covers two crop years, 1934-35 and 1935-36.

The area lies in a typical summer rainfall region, rain falling mainly during the five months November to March. Judging from average rainfall conditions together with a warm summer temperature and excellent soils, the Springbok Flats is fairly well adapted to the production of peanuts and maize. The variability of the rainfall from season to season and the frequent occurrence of dry spells during any particular season render crop production a very speculative proposition, especially in the case of maize, which is not as drought-resistant as peanuts.

During the first season of the study the average rainfall was considerably below normal. In addition to this several dry spells were experienced during the growing season. In the following year the average rainfall was again below normal, but a better distribution of the rain during the growing season resulted in considerably better crops than were obtained during the previous season.

The Springbok Flats lie in a region which is in the transition stage from ranching to cropping. The farms included in this study have, however, practically passed this stage and crop production has become a most important factor in the farm organisation. The farms on the Springbok Flats averaged just under 1,000 morgen in total area, of which approximately one-fourth is devoted to crop production. Farms on the southern flats are somewhat more intensively cultivated than those on the northern flats. Peanuts increase in importance in the farm organisation from south to north, while in the case of maize the situation is reversed. On an average, a larger area per farm is devoted to peanuts than to maize on the northern flats and a larger area is devoted to maize than to peanuts on the southern flats.

Crops, other than peanuts and maize, play an insignificant part in the farm organisation of the area. The crop rotation system followed is therefore largely one between peanuts and maize. In many instances farmers have

* Department of Economics and Forestry, Union of South Africa, Bulletin 196.

grown peanuts on the same lands for many consecutive seasons. Such a poor cropping system must necessarily have a detrimental effect on the productivity of the soil in the long run. Continuous cropping of peanuts on the same lands, year after year, is probably one of the main causes of wind erosion in the area. The problem of crop rotation is one of cardinal importance and is in urgent need of investigation.

The majority of the farms studied have a total area ranging from 400 to 1,200 morgen and a crop area ranging from 100 to 300 morgen per farm. On the majority of the farms less than 100 morgen are planted to peanuts. The tendency is, therefore, to plant relatively small areas to peanuts, while large-scale producers are the exception rather than the rule. In the case of the area under maize the farms are more evenly distributed in the various groups, although the group with 50 to 100 morgen under maize contains the largest number of farms.

The utilisation of the farm land differs with the total area of the farm. It was found that with an increase in the total area per farm there is a decline in the percentage area in crops, but a corresponding increase in the percentage area in grazing land. Thus, in the group of smallest farms the area under crops comprises 39 per cent. of the total farm area, as compared with only 18 per cent. in the case of the group of largest farms. The relative importance of crops and grazing therefore changes considerably with a change in the total area of the farm, the smaller farms being worked more intensively than the larger ones.

The average value per farm on the Springbok Flats is just over £4,000, of which approximately 68 per cent. is invested in land and improvements, 19 per cent. in livestock and 13 per cent. in machinery and implements. The relative importance of these capital items differs according to the size of the farm. A higher percentage of the capital is invested in land and improvements in the case of the large farms than in that of the small ones. The capital investment figures further indicate that the very large farms have a smaller percentage invested in livestock than the relatively small farms. This shows that the very large farms are not used as productively as are the smaller farms, otherwise the percentage capital invested in livestock would remain more or less constant for all the size-groups.

The total investment in cattle comprises approximately 85 per cent. of the total livestock capital. The remainder is invested in sheep and goats, pigs, horses, mules and donkeys, and poultry. It was found that 14.2 animal units were, on an average, kept per 100 morgen of land, including grazing and cropland.

So far as improvements are concerned the dwelling forms the most important single investment item. Boreholes, windmills, and reservoirs make up approximately 30 per cent. of the total improvements. This percentage therefore shows the importance of the water supply in this area.

The present debt situation of agriculture on the Springbok Flats must be viewed with concern. The average indebtedness per farm comprises 48 per cent. of the total real estate (land and improvements) and 32 per cent. of the total capital. The seriousness of the debt situation is borne out by the fact that 25 out of 58 farms have an indebtedness equal to more than 60 per cent. of their real estate value. These farmers should do their utmost to redeem their debts as much as possible in order to avoid any serious consequences.

The farms in the area are, with few exceptions, owned and not rented. Some farmers, however, rent additional land in order to increase their size-unit. For the area as a whole 85 per cent. of the farm land is owned and only 15 per cent. rented.

The monthly distribution of labour requirements on the Springbok Flats shows a very strong seasonal demand. The type of farming practised is of such a nature that little can be done to obtain a more even distribution of the labour requirements over the entire year. The increasing scarcity of seasonal labour, due largely to the great demand by the mines and other industries in the cities, is becoming a very severe problem and will probably force farmers in the area into greater mechanisation of their farm businesses in order to make them less dependent on native labour.

The receipts over the two-year period averaged £1,130 per farm, the figure for the Southern Flats being considerably higher than that for the Northern Flats. The importance of crops in the organisation of the farm business on the Springbok Flats is illustrated by the fact that, over the two-year period covered by the study, three-fourths of the farm receipts were derived from the crop enterprises and one-fifth from livestock. For the area, as a whole, peanuts proved to be a more important source of receipts than did maize. On the Southern Flats, however, maize and peanuts were approximately of equal importance as a source of cash income. Crops, other than peanuts and maize, play a more important part as a source of farm receipts on the Southern than on the Northern Flats.

The distribution of the farm receipts gives a good indication of the type of farming practised in the area. In many individual cases there is, however, a very poor balance between the crop and livestock enterprises. The similarity in the returns from the livestock enterprise and the great variation in the returns from crops during the two years of the study forces one to the conclusion that further development of the livestock enterprise on the Springbok Flats will have a great stabilising effect on farming there.

The farm expenses averaged £576 per farm for the whole area. Labour forms the most important single item of expenditure, comprising approximately one half of the total expenses. Other important items of expenditure are the net decrease in capital, the cost of bags, and running expenses in connection with the tractor and lorry. These items, together with labour, account for

three-fourths of the total farm expenses. The remaining items are, individually, of relatively small importance.

The net farm income for the whole area averaged £554 per farm. This figure represents, however, only the difference between farm income and expenses without taking into consideration any interest on the capital invested in the farm business. It is, therefore, a poor measure of financial success and should be avoided when comparing the financial results of two or more farm businesses.

The operators' earnings for the whole area averaged £352 per farm. This item is a very good measure of financial success and represents the reward of the operator for managing his farm business after all expenses and interest on the farm capital have been met. This measure places two or more farms on a comparable basis so far as financial success is concerned.

The return on the capital investment per farm is another good measure of financial success. It was found that, for the average of all the farms in the two-year period, a return of 7.8 per cent. was made on the farm capital. This indicates that in general farming on the Springbok Flats is financially successful under the conditions which prevailed during the two seasons.

Although farming in the area was generally successful over the two-year period there was a great variation in the financial success of individual farms. A detailed analysis was made of the various factors related to the success of the different farms. These factors can be considered as having either a primary or a secondary relationship with the financial success of the farm businesses. The primary factors have a direct and causal relationship with financial success, while the secondary factors are merely " related " to financial success and do not influence it primarily.

The most important causal factors affecting the financial success of farming in the area are those in connection with size, yields, price, labour efficiency and capital efficiency.

No consistent relationship was found between the total area of the farms and operators' earnings used as a measure of financial success. On the large farms the veld is usually not put to its full use, while in many cases part of it lies idle. The large farm has, therefore, to carry an additional interest charge without yielding any additional return.

The area under crops showed a very strong positive relationship with operators' earnings. A large crop area per farm is therefore an important factor for financial success. No relationship was found between the area in crops and crop yields. Farmers with a small crop area therefore stand the same chance of obtaining good or poor yields as do those with a large crop area.

The area in the two important crops, peanuts and maize, is also an important factor in the financial success of the farm business. An increase in the area under peanuts per farm results in a substantial increase in operators'

earnings. It was found, however, that an increase in the peanut area above 150 morgen per farm resulted in no further increase in operators' earnings. In fact, the group of farms with the largest area under peanuts, or those with an average of 218 morgen per farm, had lower operators' earnings than the previous group with an average of about 130 morgen per farm. Under present conditions there appears, therefore, to be a limit to the profitable extension of peanut production per farm on the Springbok Flats.

An increase in the area under maize per farm results in a striking increase in operators' earnings. The area under maize can, however, be profitably expanded to a greater extent than in the case of peanuts. Labour is a much more important factor in peanut than in maize production and, consequently, will sooner become a limiting factor in the expansion of peanut production than in maize production.

In showing the influence of peanut or maize area on operators' earnings above, the yields per morgen remain more or less normal in the various groups. An increase in the area of any of these crops at low yields has a relatively small influence on operators' earnings, whereas at high yields the area factor has, relatively, a greater effect on operators' earnings.

The total capital value per farm was found to be a better measure of size than was the total area. The importance of the size-factor in financial success was well illustrated by the positive relationship between capital value per farm and operators' earnings.

Crop yields are a very important primary factor so far as the financial success of the farm business on the Springbok Flats is concerned. An increase in crop yields per morgen results in a striking increase in operators' earnings. Yields are largely dependent on climatic conditions during any particular season and, since they form such an important factor as regards financial success, it is evident that those farms, which are practically wholly dependent on crops, show a marked fluctuation in financial returns from year to year.

Although a good-sized unit is important in the success of the farm business, it has been found that those farms with a relatively small area under crops and good yields are more successful than are those with a large area under crops and poor yields.

As might be expected, the price factor has an important influence on operators' earnings. A great difference was found between the prices received for similar products by different farmers. Various factors, such as quality of the product, time of selling and the farmer's ability to market his product, account for the difference in the prices received by various farmers. Other factors being constant, an increase in the average price received results in an increase in operators' earnings per farm.

An important factor in farming on the Springbok Flats is the extent to which intensification might be advisable. It was found that an increase in the percentage area under crops resulted in an increase in operators' earnings.

It was found, however, that there is a limit to intensification as was borne out by the fact that the farms as a group, with more than 50 per cent. of their total area under crops, were financially less successful than were those with a crop area of 40 to 50 per cent. of the total area. There appears, therefore, to be an optimum balance betwen crop land and other land, and that intensification should not be carried beyond certain limits.

Although it was found that a very large percentage of farm receipts from crops resulted in marked financial success no definite conclusions should be based on this relationship, in view of the relatively short period covered by this study. To determine the most profitable ratio between receipts from crops and receipts from livestock the financial results of the same farms should be studied over a fairly long period.

Striking secondary relationships were found to exist between certain financial ratios and operators' earnings. An increase in the value of the gross output per £100 labour cost resulted in a striking increase in operators' earnings. An increase in the total production per farm, therefore, takes place at a greater rate than does the increase in labour expenses. With a high total production the farm labour is used more productively than with a small total production.

Furthermore, operators' earnings are closely associated with the percentage of the farm receipts paid out to labour. Thus, as the percentage of labour cost to farm receipts declines the operators' earnings, on the other hand, show a striking increase. For a farm to be financially successful the labour expenses should be kept as low as possible, as compared with farm receipts.

There exists an optimum relationship between labour expenses, as a percentage of total farm expenses and operators' earnings. As the percentage increases from less than 40 per cent. to 55 per cent. the operators' earnings also increase, but they decline with a further increase in the percentage labour expenses of total expenses.

Certain capital ratios also show a striking relationship with operators' earnings. Receipts per £100 farm capital and operators' earnings show a strong positive relationship.

The average capital turnover for the whole area was found to be 3.6 years. An increase in the rapidity of the capital turnover, i.e. a decrease in the number of years for receipts to equal capital, is accompanied by an increase in operators' earnings.

The productivity of the livestock enterprise is another important factor in the financial success of the farm business on the Springbok Flats. Those farms which have a productive livestock enterprise are, financially, far more successful than are those farms where the livestock enterprise is relatively unproductive and neglected. It was found that an increase in the total livestock income per £100 capital invested in livestock resulted in an increase in operators' earnings. An improvement in the type of cattle kept on the

Springbok Flats and greater attention to the livestock enterprise should do much towards increasing the productivity of that enterprise.

A correlation analysis shows that 71 per cent. of the variation in operators' earnings is caused by the combined effect of area under crops, crop yields and price. The partial correlation analysis indicated that crop yields were the most important single factor affecting operators' earnings, with area under crops taking second and price third place. This analysis has, therefore, brought out the fact that, although the price factor is significantly important for financial success, the other two factors are relatively more important.

Although the analysis has illustrated the importance of crop production in financial success, any conclusions drawn from the relationship should be modified by the variability of crop yields and, consequently, crop returns. The co-efficient of variation in peanut yields (42 per cent.) and in maize yields (72 per cent.) indicates the great variability of crop yields and the insecurity of crop production on the Springbok Flats. The more farmers rely on crops, especially maize, for their cash returns, the more speculative would be the type of farming practised by them.

Greater stability can be introduced into the agriculture of the area by the development of a more productive livestock enterprise. Although maize is a very speculative cash crop, good results are invariably obtained when silage and stover are made from it. The Springbok Flats is a natural feeding area and, as such, should be further developed. This would place farming there on a much firmer basis than is at present the case.

The costs of production and the relative profitability of peanuts and maize were determined. It was found that it costs 66 shillings to produce a morgen of peanuts at an average yield of 11.2 bags per morgen, and 36 shillings to produce a morgen of maize at an average yield of 5.6 bags per morgen. Labour was by far the most important single cost item in the production of both products; 34 per cent. in the case of peanuts and 27 per cent. in that of maize.

The greater intensity of peanut production as compared with maize is illustrated by the fact that it takes approximately 26 man-workdays to produce a morgen of peanuts and nine man-workdays to produce a morgen of maize, i.e., at their respective average yields. In the case of peanuts the man-workdays are used in greater proportion in connection with harvesting operations, while in that of maize they are used in greater proportion in connection with production operations.

The cost per unit of peanuts as well as per unit of maize is greatly affected by the yield per morgen. The production of both these products on the Springbok Flats is subject to the law of decreasing costs. Under very high yields their production is subject to the law of constant costs. The analysis indicates that the point where increasing costs set in has not yet been reached.

Labour efficiency is also an important factor in the cost of production of both these products. At the same yield per morgen, those farmers who use a

relatively small amount of labour produce these products more economically than do those using a relatively large amount of labour. Thus, in spite of the relative cheapness of native labour, an efficient use of it leads to more economical production.

A multiple correlation analysis of yield per morgen and man-days per morgen shows that 74 per cent. of the variation in the cost of peanut production per bag is accounted for by these two factors.

The area, in either peanuts or maize, per farm was also found to have some influence on the cost per unit. Those farms with a relatively large area under either of these crops produced more economically than did those farms with a relatively small area under either.

Both peanuts and maize returned fair profits under the yield and price conditions during the two years covered by this study. At an average yield of 11.2 bags per morgen and an average price of 9.24 shillings per bag, the profits in peanut production averaged £2.47 per morgen or 4.4 shillings per bag. In the case of maize, at an average yield of 5.6 bags per morgen and an average price of 10.18 shillings per bag, the profits averaged £1.23 per morgen or 4.7 shillings per bag.

Profits per unit of these crops vary greatly according to yield and price. When comparing the profitability of these two crops due consideration should be given to the relative yields and prices. A correlation analysis for peanuts shows that yield per morgen and profit per bag are significantly related, as are also price per bag and profit per bag.

At a price of approximately 9s. per bag for both peanuts and maize it was found that in the case of the former a minimum yield of about five bags per morgen and a minimum yield of about 3.5 bags in that of the latter was necessary to cover the cost of production. At similar yields and approximately equal prices, maize production gives a higher profit per morgen than does peanut production. But only in a few cases were the maize yields as high as the peanut yields. The profitability of the two crops should therefore be compared on average conditions; under these peanuts yield higher profits per morgen than does maize.

During the two years covered by this study both peanut yields and prices showed greater stability than did maize yields and prices. This fact, however, as well as the greater profitability of peanuts per morgen does not mean that the farmer should ignore maize and concentrate only on peanuts. Both crops fit well into the farm organisation of the area. The whole farm should be considered as one unit and, although the one product might appear more profitable than the other, both would probably be indispensable to the success of the farm business as a whole. On the Springbok Flats, both peanuts and maize are practically indispensable, but the latter should play a less important role as a cash crop and should be developed more in combination with livestock. Such a change in the farm organisation would, in addition to its many

other benefits, tend to stabilise the agriculture of the area. Nature cannot be changed. A system of farming should therefore be followed which would be least affected by fluctuating natural conditions.

News

PROF. JOHN T. SHARE-JONES, who recently retired from the post of Director of Veterinary Studies at Liverpool University, has been adopted as prospective Liberal candidate for the Shrewsbury Division at the next General Election.

Prof. Jones is well known in veterinary and agricultural circles. He is a practical farmer. Although we may not all agree with his political views, it is our earnest hope that he may succeed at the election and be elected an M.P. Prof. Jones is one of the few veterinarians who has taken an active interest in Parliamentary and local government work. We can be certain that, if he be elected, the veterinary profession will have a champion in the House of Parliament who will fight without fear or favour on our behalf. It has long been recognised that veterinarians need someone who is competent to represent them at the Mother of Parliaments. Let us hope that, for the time being, we may temporarily drop our political views and strain every effort to secure his election.

Reviews

La Chirurgie du Bétail et des Animaux de Basse-Cour. First Edition. By M. BERTHELON, Agrégé des Ecoles Nationales Veterinaires. Paris: Vigot Frères, 1939. Pp. 185 with 198 figures in the text. 50 francs.

THIS book in the French language is written by M. Berthelon, a Fellow and Professor of the National Veterinary Schools, and is edited by the well-known house of Vigot Frères, of Paris. It is a work worthy of commendation and one which ought to be exceptionally useful to country practitioners as it deals with the surgery and control of ruminants and the animals of the farm.

In this respect it is rather unique and a milestone in the period when equine practice is on the decline, and country and farm medicine and surgery and the ailments of farm animals should receive increased scientific attention.

The first chapter deals with the control of bovines, small ruminants and the pig. The second chapter discusses anæsthesias (general, local and

regional). Chloral hydrate is exclusively recommended for bovines. For the pig, chloroform and ether, chloral, and pernocton (a narcotic-butyl-bromallyl-maloylureid-soda), ethyl chloride and electric current. Rabbits may be anæsthetised comfortably with ether.

Local anæsthetics are cocaine, tutocaine, novocaine, percaine.

Epidural anæsthesia is fully discussed and illustrated. Novocaine, tutocaine, percaine, etc., are recommended. To retard absorption adrenalin may be added to the solution and the addition of bicarbonate of soda allows for a longer and more complete anæsthesia. Formulæ of the additions are given for one and two hours' anæsthesia.

Anæsthesia of the sciatic nerve in bovines is recommended for amputation of the claws and other painful limb conditions needing operation. Tutocaine is the anæsthetic of choice.

Chapter three deals with injections, and four with bleeding.

There are 35 pages on castration of the male (bull, ram, goat, pig, rabbit and cockerel). The use of the Burdizzo and Erchini castrators is described and illustrated. A method of castrating bulls largely used in France, and given due prominence in this book, is known as "*Bistournage*" (torsion). The testicles are pushed up towards the inguinal canal and are held in this position by wire ribbon or strong cord round the bottom of the scrotum. The testicles remain fixed in the upper part of the scrotum and the cord remains twisted. The obliteration of the vessels at the torsion level causes progressive atrophy of the testicles and at the end of two or three months the organ is reduced to the dimensions of a pigeon's egg and consists of fibrous tissue infiltrated with lime salts.

Berthelon is of opinion that the claw method of castration ought to be abolished.

Ovariotomy and ovariectomy have 21 pages. Chapters 7, 8, 9, 10 and 11 deal with operations on the digestive organs, limbs, eye, horns and urinary organs.

The illustrations in the book are quite good and the printing excellent.

M. Berthelon has done good service for the veterinary profession in the production of this work, and it should have a good sale among those who practise among the animals of the farm.

When issued in paper covers it should be bound and placed on the veterinarian's bookshelf.

The Fetal Pig, An Introduction to Mammalian Anatomy. By HAZEL E. FIELD, Ph.D., Associate Professor of Biology, Occidental College, Los Angeles, California, U.S.A. Pp. 53. London: Humphrey Milford, Oxford University Press. Price 75 cents.

THIS is a useful handbook for both students of biology and anatomy. The author states that probably no mammal is ideal for dissection in an intro-

ductory course, but the fetal pig probably fulfils this general introductory need better than any other laboratory form because of its availability, relatively low cost, ease of dissection and similarity in structure to the human body.

Table of contents:

I. External structures and skeleton.
II. General internal anatomy.
III. Urogenital system.
IV. Circulatory system.
V. Digestive and respiratory systems.
VI. Nervous system.
VII. Glossary and Index.

The diagrams are original and excellent in every way. Even the most backward student of biology who procures a fetal pig and this little handbook cannot help but learn the subject. The author deserves to be congratulated for this excellent handbook on Mammalian Anatomy. We envy the students of to-day who have such books as this alongside to guide them and make the subject so interesting.

Parasites and Parasitic Diseases of the Domestic Equidæ, for the use of Veterinary Surgeons at home and abroad *(Parasites et Maladies Parasitaires des Equidés Domestiques, a l'usage des Vétérinaires métropolitains et coloniaux).* By G. CARPENTIER, Docteur-Vétérinaire Licencié és Sciences, Ex-Chef de Travaux de Parasitologie à l'Ecole Nationale Vétérinaire d'Alfort. Pp. 524. Publishers: Vigot Frères, Editeurs, 23, Rue de l'Ecole de Medicine, 23. 1939. Price 120 francs.

THE author of this book, written in French, is a person obviously well adapted for such work. Evidently M. Carpentier has devoted years of his life to this branch of science. Although it deals mainly with parasites of the horse, yet it contains many references to parasites of the other domesticated animals. The numerous illustrations in themselves are a study. The author has gone into detail describing both internal and external parasites, symptoms, lesions, diagnosis, prognosis, prophylaxis and treatment. This proves that the horse is still considered an important animal in France. Veterinary students and practitioners who wish to be up to date in veterinary parasitology should have this book in their library. We wish to congratulate the author, and we hope that he will publish in the near future another volume on parasitology of the other domesticated animals.

ERRATUM

IN the appreciation of Sir Frederick Hobday by Prof. James McCunn that appeared in the July, 1939, issue of the journal on page 255, Sunday, May 11, should have read Sunday, June 11.

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